QUALITY CONTROL OF *EDEL* COCOA (COCOA PRECIOUS) AT PT. PERKEBUNAN NUSANTARA XII (PERSERO) BANJARSARI GARDEN JEMBER REGENCY

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ABSTRAK

Penelitian ini bertujuan untuk (1) mengetahui cacat biji kakao edel (2) mengetahui cacat biji kakao edel di kebun Banjarsari masih dalam batas kendali atau tidak (3) mengetahui cacat dominan, dan (4) menganalisis penyebab dan tindakan yang diusulkan untuk memperbaiki cacat biji kakao edel di PTPN XII (Persero) Kebun Banjarsari. Metode dasar penelitian adalah deskriptif analitis. Metode penentuan informan kunci dan responden dilakukan secara purposive sampling. Hasil penelitian menunjukkan bahwa (1) Cacat biji kakao edel terdiri dari 2753,2 kg biji prongkol, 2143,2 kg biji pecah, 1898,47 kg biji kulit hitam, 1.667,34 kg biji kakao, biji berjamur (berjamur) sebanyak 34,193 kg, dan bibit serangga sebanyak 0,69 kg. (2) Analisis grafik menemukan bahwa batas toleransi mutu biji kakao edel bervariasi selama 5 tahun, Penyimpangan cacat pada kakao edel terjadi pada bulan ke-9 (September 2015) dan bulan ke-53 (Agustus 2019). (3) Analisis diagram pareto, cacat yang dominan pada biji kakao edel adalah prongkol, biji hancur dan biji kulit hitam. (4) Fishbone diagram mengidentifikasi faktor-faktor penyebab cacat biji kakao edel yaitu metode, manusia, bahan, lingkungan. Usulan tindakan perbaikan untuk masing-masing faktor tersebut harus segera dilaksanakan untuk mengatasi masalah kerusakan yang dominan. Rekomendasi yang diberikan adalah mengadakan pelatihan rutin minimal sebulan sekali, pihak perusahaan melakukan alternatif tindakan dengan menanam diversifikasi tanaman penutup tanah, meningkatkan kebersihan secara rutin, melakukan sanitasi dan pembersihan gulma di sekitar areal kebun.

Kata kunci: biji kakao edel, ptpn xii (persero) kebun banjarsari, mutu, statistical quality control (sqc)

ABSTRACT

This research aims to (1) knowing the defects of the *edel* cocoa beans (2) knowing the defects of the *edel* cocoa beans in the Banjarsari garden were still within the control limit or not (3) knowing the dominant defects, and (4) analyzing the causes and proposed actions to improve the defects of the *edel* cocoa beans in PTPN XII (Persero) Kebun Banjarsari. The basic method of research is descriptive analytical. The method of determining key informants and respondents was carried out by purposive sampling. The results showed that (1) The defects of the *edel* cocoa beans consisted of 2753.2 kg of prongkol beans, 2143.2 kg of broken beans, 1898.47 kg of black skin seeds, 1667.34 kg of cocoa beans, moldy seeds (moldy) as much as 34.193 kg, and insect seeds as much as 0.69 kg. (2) Chart analysis found that the quality tolerance limits of *edel* cocoa beans varied for 5 years, Deviation of defects in *edel* cocoa occurred in the 9th month (September 2015) and the 53rd month (August 2019). (3) Pareto diagram analysis, the dominant defects in *edel* cocoa beans are prongkol, crushed beans and black skin beans. (4) The Fishbone diagram identifies the factors that cause *edel* cocoa bean defects are method, human, material, environment. Proposed remedial action for each of the factors must be implemented immediately to overcome the dominant damage problem. The recommendation given is to hold routine training at least once a month, the company to take alternative actions by planting diversified cover

crops, improving cleanliness regularly, performing sanitation and cleaning weeds around the garden area.

INTRODUCTION

Agriculture has an important role in Indonesia's economic activities. The contribution of the plantation sub-sector to GDP amounted to USD 387,501.5 or around 3.72% in 2018. This position is in the first place in the Agriculture, Livestock, Hunting and Agricultural Services sectors (BPS, 2018). Plantation is all activities that cultivate certain plants on land and / or other growing media, process and market the goods and services of these plants, with the help of science and technology, capital and management to create welfare for plantation business actors and the community (Center for Plantation Research and Development, 2010).

One of the leading plantation commodities in Indonesia is cocoa. Cocoa beans are an export product in Indonesia which generated a positive contribution (surplus) to the trade balance for plantation commodities of US $ 776,151,000 in 2014 (Respati *et al.*, 2015). According to the (Directorate General of Plantation, 2019), Indonesia is currently the fourth largest producing country in the world. Cocoa is divided into three major groups, namely Criollo, Forastero, and Trinitario. Criollo in the cocoa trade system including fine-flavored cocoa group, Forastero including bulk cocoa and Trinitario is a Criollo hybrid with Forastero (Towaha, E and Rubiyo, 2013). The Criollo type includes high quality cocoa or noble cocoa that has The characteristics of the endosperm are white, thin fruit skin, and easy to slice, shape full round seeds, blunt-shaped fruit tips, the fermentation process is faster, susceptible to pests and diseases, and the taste is not too bitter.

One of the plantations in East Java that cultivates cocoa is PT. Perkebunan Nusantara XII (Persero). State plantations are selected based on *edel* cocoa beans (noble cacao) cultivated only by a few old plantations in Java. PT Perkebunan Nusantara XII (Persero) has several work units, one of which is Kebun Banjarsari. PTPN XII (Persero) Kebun Banjarsari Afdeling Gerengrejo cultivates two types of cocoa plants, namely bulk cocoa and *edel* cacao. The research focused on *edel* cocoa beans because they are of high quality and have a higher selling price than bulk cocoa in the international market. PT. Perkebunan Nusantara XII (Persero) is able to generate 153,884.70 billion rupiah of GDP. The contract price for *edel* cocoa beans is USD 2.5 per kilogram of dry beans.

The production of *edel* cocoa beans in the Banjarsari Afdeling Gerengrejo garden has fluctuated every year. This is because there are errors in the production process including too long fermentation, reversal errors when drying using sunlight, errors in drying temperatures that cause smokey. (Towaha, E and Rubiyo, 2012) states that fluctuating production levels have resulted in a decrease in the quality of cocoa beans. This causes Indonesian *edel* cocoa beans to be unable to compete in the international market. *Edel* cocoa quality problems of PT. Perkebunan Nusantara XII (Persero) Kebun Banjarsari in the export market is the presence of contaminated smokey (smoke) in cocoa beans, so the sales value is low.

Based on the organoleptic test of the taste of *edel* cocoa beans, Afdeling Gerengrejo Kebun Banjarsari at the Indonesian Coffee and Cocoa Research Center in 2019, there was a taste of moldy (moldy) and over fermented beans. These two factors can reduce the taste and quality of cocoa on the world market. Errors in the production process (post-harvest) can occur, including errors in fermentation time, short drying time, so that the water content is not

up to standard (<7%) and it is easy to grow fungi or bacteria. Forms of production process errors can reduce the quality of the *edel* cocoa beans. Afdeling Gerengrejo Kebun Banjarsari PT. Perkebunan Nusantara XII (Persero).

Product quality is an important factor that needs to be given solutions to errors during the production process of *edel* cocoa beans. Increased education, purchasing power and consumer awareness of nutritional value have awakened consumer awareness of the importance of product quality (Anom Yuarini, Satriawan and Oka Suardi, 2015). The number of similar businesses demands competition. According to (Weenas, 2013). every effort is required to pay full attention to the quality of the products produced. Quality control is carried out to provide information about the suitability of goods produced with product design specifications. If quality control is carried out properly, the company's goal of creating high-quality products can be achieved (Jacobs and Chase, 2014).

Quality standards are determined as benchmarks for quality control supervision. Every piece of cocoa bean to be exported must meet the relevant quality standard requirements. The provisions of the SNI for Cocoa Beans have been followed up with the Regulation of the Minister of Agriculture Number S1 / Fermentation / OT.140 / 9/2012, concerning guidelines for handling post-harvest cocoa. This effort aims to improve and maintain the quality of cocoa beans and be able to elevate the national cocoa so that it can compete both in the domestic and global markets and contribute to supporting higher economic growth, not only depending on the variety and environment of cocoa growth, but especially processing. cocoa beans to maintain good quality (Manalu, 2018). In general, the damage that occurs to cocoa beans during the harvest process, post-harvest handling, and storage processes will cause a decrease in quality (weight loss, quantity and quality). Types of damage found in cocoa beans include physical and mechanical,

biological, microbiological and chemical damage (Haryadi and Supriyanto, 2012).

The description above encourages researchers to examine more deeply the analysis of quality control of *edel* cocoa beans at PTPN XII (Persero) Kebun Banjarsari withusing one of the quality control methods, namely the Statistical Quality Control (SQC) method. This study aims to determine the defects that occur in the production process of *edel* cocoa beans, the dominant causes of defects in *edel* cocoa beans, the factors that affect the quality of *edel* cocoa beans.and provide formulation of alternative solutions that are considered relatively suitable for increasing the quality production of *edel* cocoa beans at PT. Perkebunan Nusantara XII (Persero) Kebun Banjarsari, Jember Regency.

RESEARCH METHOD

Basic Research Methods

The basic method used in this research is descriptive analytical method. Analytical descriptive method with the characteristic of focusing on solving problems that exist in the present, on actual problems, the data collected is first compiled, explained and then analyzed (Wirartha, 2006).

Site Determination Method

This research was conducted at PT. Perkebunan Nusantara XII (Persero) Kebun Banjarsari, Jember Regency which is determined purposively (intentionally), meaning that subject selection is a technique of determining the location to provide the information needed on purpose based on special considerations of a population of a place (Ulber Silalahi, 2006).The reason for choosing the location was because Banjarsari Garden was one of PTPN XII's mainstay gardens from other plantations in cultivating and increasing cocoa production, especially *edel* cacao. PTPN XII (Persero) Kebun Banjarsari only carries out quality control, especially the production process with SOPs that are still simple and not specific for each

output (cocoa beans) so that no real corrective action has been taken.

Sources and Types of Data

The types of data used are primary data and secondary data.

Key Informant and Respondent Determination Methods

The method of determining key informants and respondents is done by using purposive sampling method for leaders (managers, plant assistants, technical assistants and processing) and employees. This research requires samples with certain criteries as experts to causes of disability in *edel* cocoa in PT. Perkebunan Nusantara XII (Persero) Banjarsari Garden. The purpose of sampling is to produce logical results that can be considered representative of the population. Data collection techniques are carried out through interviews, observation, recording, literature study, and documentation.

Data analysis method

Methods of data analysis using the Statistical Quality Control (SQC) method. According to Stevenson and Chuong (2014), one of the most important tools in SQC is a control chart that has an upper and lower limit. The steps taken include:

1. Compilation of Company Secondary Data

Secondary data of the company contains production time, amount of production, type of damage / defects, and number of damage / defects of *edel* cocoa beans for 5 years (January 2015 - October 2019). The compilation of company secondary data uses the help of Microsoft Excel applications (Nasution, 2005).

2. Analysis of the Proportion Error Control Chart ($\overline{p}$ -chart)

Control Chart is a technique known as the chart method used for know whether the data is within control limits or not. The type of control chart used in this study is the error proportion control chart or *p*-chart. The number of samples used for chart-making varies. The number of defects in the reject product will not exceed the number of samples (Tannady, 2015). The steps for calculating the error proportion control chart are as follows:

a. Determination of average damage

$$\overline{p} = \frac{np}{n}$$

Where $\overline{p}$ is the mean of defects, πp is the number of failures in the sub-group, π is the number of failures in the sub-group.

b. Central Line (CL) Calculation

$$CL = \overline{p} = \frac{\sum np}{\sum n}$$

Where $\sum np$ is the total number of failures, $\sum n$ is the total number checked.

c. Upper Control Limit (UCL) calculation

$$UCL = \overline{p} + 3\sqrt{\frac{\overline{p}(1 - \overline{p}.)}{n}}$$

Where $\overline{p}$ is the average defect, π is the number of production.

d. Lower Control Limit (LCL) calculation

$$LCL = \overline{p} - 3\sqrt{\frac{\overline{p}(1 - \overline{p}.)}{n}}$$

Note: $\overline{p}$ is the average defect, π is the number of production.

3. Pareto chart

Pareto diagram is a tool used to compare variations / distribution of data arranged according to size to determine the importance or priority of variations (Bakhtiar, Tahir and Hasni, 2013). Making pareto diagrams using the help of the Microsoft Excel application.

4. Cause and Effect Diagram (Fishbone Diagram)

According to Nasution (2010), a fishbone diagram is a structured approach that may carry out a more detailed analysis in determining the causes of a problem, discrepancies, and gaps that occur. Fishbone diagrams are arranged based on the priority of repair from the highest /

largest number of defects that occur in *edel* cocoa beans. Fishbone diagrams are used to determine the main causative elements or components in a fishbone diagram, namely humans, materials, methods, and the environment.

5. Formulating Corrective Actions

Corrective action in order to improve the quality of *edel* cocoa bean production at PTPN XII (Persero) Kebun Banjarsari Jember Regency was formulated from the results of interviews and discussions with key informants. Information about the problem that exists is extracted in depth. The information that has been obtained is then used to solve existing problems.

RESULTS AND DISCUSSION

Types of Defects in *Edel* Cocoa Beans

The types of damage that occurred in *edel* cocoa beans were 2753.2 kg (32.8%), broken beans, 2143.77 kg (25.23%), 1898.47 kg (22,34%), 1667.34 kg of kepek seeds (19.62%), 34.193 kg of mouldy seeds (0.40%) and 0.69 kg of insect seeds (0.01%). The number of defects in *edel* cacao beans in 5 years was 8497.6 kg with an average of 7.48% per month.

Proportion Control Chart (p-chart) *Edel* Cocoa Beans Defects at PTPN XII (Persero) Kebun Banjarsari

Proportion control chart analysis (p-chart) is used to determine whether the disability that occurs is within the control limit or not. Control Chart Analysis Results (Control p-Chart) shows that the quality limit areas of *edel* cocoa beans varied over 5 years (January 2015 -October 2019) which can be broken down every month with the results in table 1.

Figure 1 shows that the majority of *edel* cocoa production processes at PT. Perkebunan Nusantara XII (Persero) Kebun Banjarsari is still within the control limits, but not a few are outside the control limits (control). The pattern of points in the control chart *p chart* fluctuates and irregular. There are 2 points that are outside the control limit or above the UCL line and there are 5 points below the LCL line. Points that are above the UCL line are said to be uncontrollable because there are high defect values compared to points in other months. Meanwhile, a point below the LCL line indicates that there has been a change process (Krajewski *et al*, 2013).

Table 1. Upper and Lower Boundary Areas of Quality *Edel* Cocoa Beans Based on Control Analysis p chart

Year	Month	CL	Sd	UCL	LCL
2015	January	0.0748	0.0827	0.0920	0.0576
	February	0.0748	0.0895	0.0926	0.0570
	March	0.0748	0.0867	0.0772	0.0724
	April	0.0748	0.0775	0.0915	0.0581
	May	0.0748	0.0834	0.0165	0.0583
	June	0.0748	0.0699	0.0877	0.0619
	July	0.0748	0.0843	0.0958	0.0538
	August	0.0748	0.0709	0.0889	0.0607
	September	0.0748	0.1236	0.1006	0.0490
	October	0.0748	0.0594	0.0913	0.0583
	November	0.0748	0.0729	0.1241	0.0255
	December	0.0748	0.0822	0.1313	0.0183

| Year	Month				
2016	January	0.0748	0.0880	0.0981	0,0515
	February	0,0748	0,0781	0,0160	0,0588
	Maret	0,0748	0,0838	0,0941	0,0555
	April	0,0748	0,0642	0,0928	0,0568
	Mei	0,0748	0,0734	0,0881	0,0615
	June	0,0748	0,0699	0,0849	0,0648
	July	0,0748	0,0570	0,0849	0,0648
	Agustus	0,0748	0,0555	0,0858	0,0638
	September	0,0748	0,0522	0,0952	0,0544
	October	0.0748	0.0799	0.1036	0.0460
	November	0.0748	0.0794	0.1009	0.0487
	December	0.0748	0.0855	0.0918	0.0579
2017	January	0.0748	0.0701	0.0927	0.0570
	February	0.0748	0.0657	0.0888	0.0608
	March	0.0748	0.0760	0.0884	0.0612
	April	0.0748	0.0817	0.0926	0.0570
	May	0.0748	0.0580	0.0853	0.0643
	June	0.0748	0.0560	0.0827	0.0669
	July	0.0748	0.0516	0.0812	0.0684
	August	0.0748	0.0625	0.0845	0.0651
	September	0.0748	0.0573	0.0972	0.0524
	October	0.0748	0.0709	0.1457	0.0039
	November	0.0748	0.0820	0.1004	0.0492
	December	0.0748	0.0857	0.0858	0.0638
2018	January	0.0748	0.0700	0.0907	0.0589
	February	0.0748	0.0576	0.0981	0.0515
	March	0.0748	0.0827	0.0920	0.0576
	April	0.0748	0.0895	0.0926	0.0570
	May	0.0748	0.0867	0.0772	0.0724
	June	0.0748	0.0585	0.0924	0.0572
	July	0.0748	0.0803	0.1093	0.0404
	August	0.0748	0.0612	0.0924	0.0572
	September	0.0748	0.0779	0.0862	0.0634
	October	0.0748	0.0597	0.0838	0.0658
	November	0.0748	0.0698	0.1109	0.0387
	December	0.0748	0.0573	0.1209	0.0287
2019	January	0.0748	0.1102	0.1503	-0.0007
	February	0.0748	0.1295	0.1491	0.0006
	March	0.0748	0.0763	0.1426	0.0070
	April	0.0748	0.0774	0.0989	0.0507
	May	0.0748	0.0954	0.0887	0.0609
	June	0.0748	0.0636	0.0916	0.0580
	July	0.0748	0.0711	0.0900	0.0596
	August	0.0748	0.1095	0.0977	0.0519
	September	0.0748	0.0685	0.0769	0.0727
	October	0.0748	0.0529	0.0888	0.0608
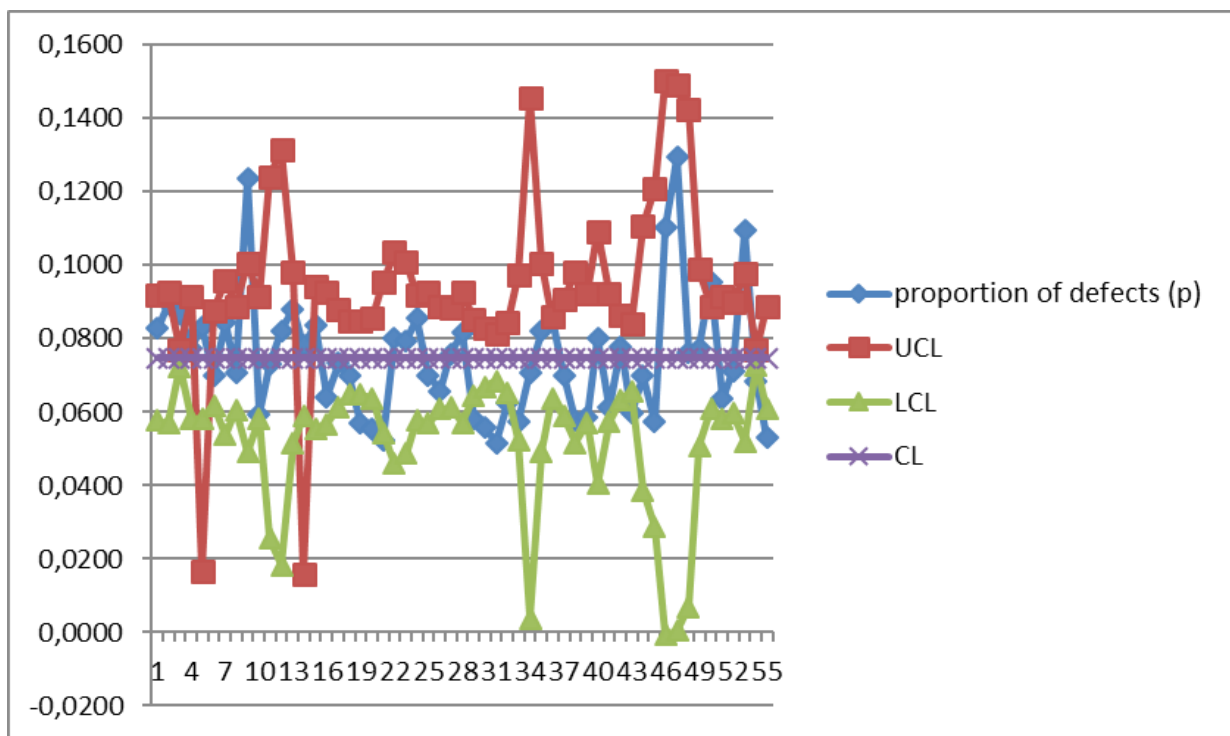
Figure 1. Control Map for Proportion of Defects in *Edel* Cocoa Beans, January 2015 – October 2019

The worst deviation shows the percentage of defects in cocoa beans *edel* the highest occurred in the 9th and 53rd months (September 2015 and August 2019) breaking the figure of more than 10%, it is seen that these dots have broken through the upper limit point (UCL). Deviation in September 2015 occurred due to a tornado which resulted in some *edel* cocoa flowers falling off and falling before pollination. So that the seeds produced are mostly black. The deviation in August 2019 occurred due to the transition period between drying which initially underwent a 2-time process, namely using sunlight and machines (mechanics).

Sudden changes in points that are out of control indicate the number of defective products. The 19th month to the 21st month (September 2016-November 2016), and the 29th month to the 32nd month (month July 2017-October 2017), these points are at the lower limit (LCL). This is because the percentage of disabilities is small, which is below 6%.

Pareto Diagram of *Edel* Cocoa Beans Defects

The Pareto diagram will rank the defect types of *Edel* cocoa beans from highest on the left to lowest on the right. The highest order becomes the dominant problem that must be resolved in the near future and continuously.

According to Gitlon *et al* (1995), the concept of Pareto pays more attention to important problems, so that it is formed between 80% - 20% where 80% of the dominant problems come from 20% of the causes. There are three dominant problems in *edel* cocoa bean defects, namely prongkol beans, broken beans, and black skin beans. These three problems have a cumulative percentage of defects, namely 79.97 %.

In *edel* cocoa production. The root of a problem subject can be viewed from 4 factors, namely, humans, tools, methods, materials and the environment. This diagram is often called a fishbone diagram. The factors causing the damage are determined to find the root cause of the damage and then some suggestions for appropriate action can be formulated.
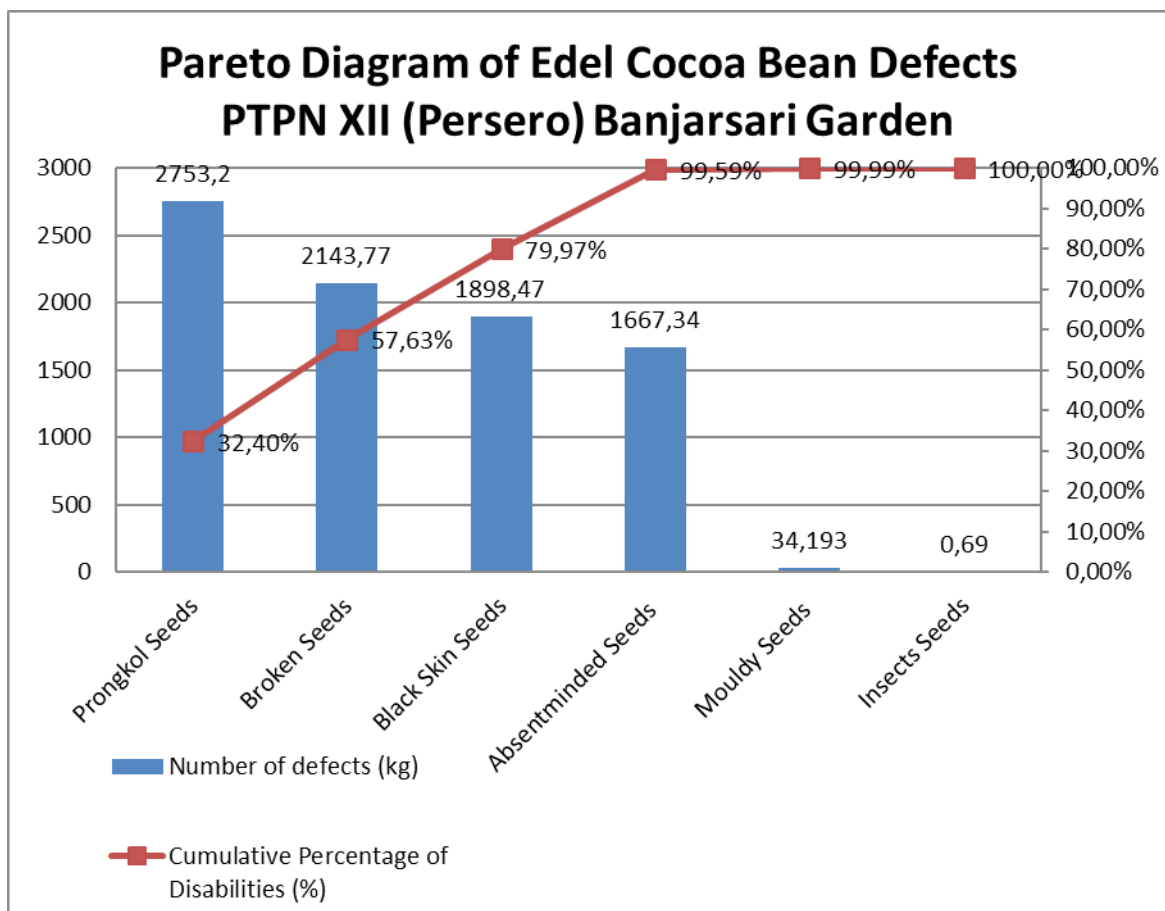
Figure 2. Pareto Diagram of *Edel* Cocoa Bean Defects

a. Prongkol seeds

Human side of the prongkol defects is caused by:
- *Delays in pest control team employees in applying pesticides.*

The EWS (Early Warning System) team was negligent in doing its job, especially in early identification of pest attacks and proper control to reduce attacks.

- *Low employee hygiene response.*

Some employees don't wear PPE (don't wear work boots, don't wear masks, dirty clothes, and don't use gloves), so viral, bacterial and fungal infections will increased. Pests and diseases can be transmitted through employees who do not comply with the applicable SOPs.

The method of malformation of the prongkol beans is caused by:
- *Too long fermentation.*

The fermentation process in *edel* cacao takes about 2-4 days depending on the amount of production harvested. Too long fermentation will result in a lot of pulp which will harden and stick between the cocoa beans. So that the shape when it is dried becomes prongkol.

- *The use of pesticides is not appropriate and maintenance of edel cocoa is not routine.*

The inaccuracy was due to the employees giving too high a dose when the *edel* cocoa plant was badly attacked, even though the pests were getting harder to control. Prongkol seeds can also be caused by supervision that is rarely carried out by the field coordinator which prevents employees from checking regularly every day. Checking is not routine because employees are not aware in maintaining and not being careful about the pests that attack the *edel* cocoa which is being produced even in the dry season, so that pest control is also rarely considered.
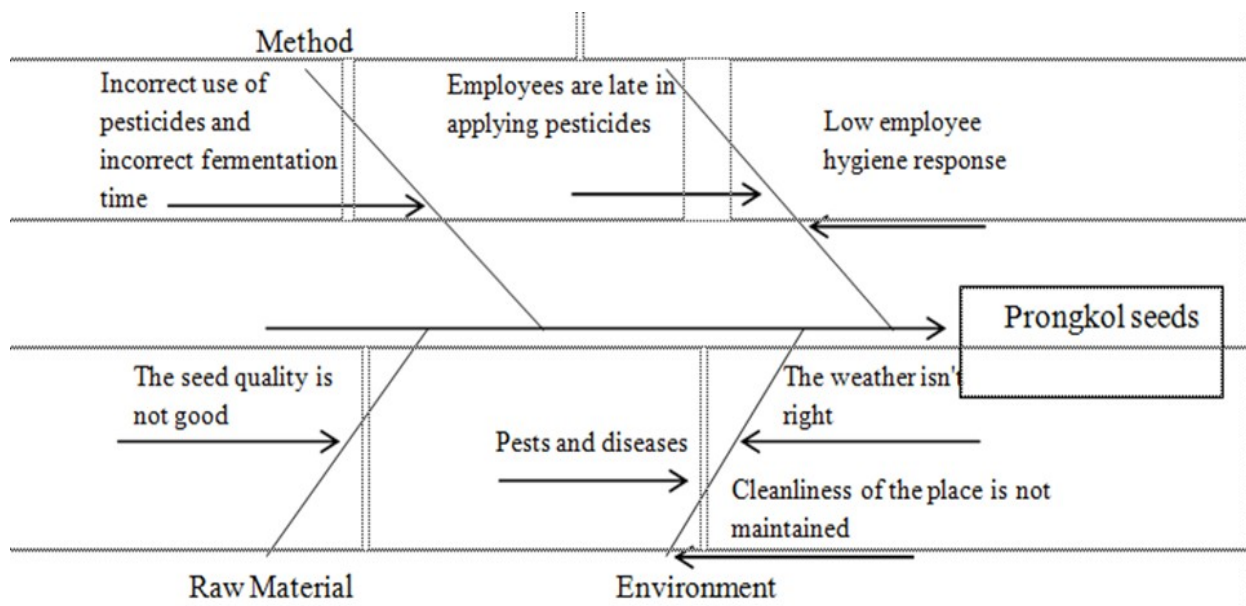
Figure 3. Cause and Effect Diagram of Prongkol Seed Defects

Raw material defects of *Edel* cocoa beans are caused by:
- *The seed quality is not good.*

The material used is cocoa *edel* which are harvested from the PTPN XII (Persero) Kebun Banjarsari plantation alone. Availability of *edel* Cocoa Those in the factory are supplied from garden shipments which regularly harvest almost every day and must be in fresh condition production required to provide targeted cocoa production *edel* that come into factory. Most of the *edel* cocoa beans from the farm are already exposed to pests so that quality control after being in the factory will be difficult.

Environmental defects of prongkol seeds are caused by:
- *Unsuitable weather.*

Drastic weather changes make it difficult for employees to predic prevention of pests and diseases in *edel* cacao plants. This affects watering to keep the air moist in the land, so that the temperature remains stable for the *edel* cacao plant.
- *The presence of pests.*

This pest is a cocoa pod borer (CPB) with new attacks that can be seen from the time the fruit is split, the flesh of the fruit will appear black friction marks, the beans stick together, are black in color, wrinkled, and weigh very lightly. The young fruit will cause serious damage because the seeds are sticky to each other and firmly attached to the fruit skin, so that it will affect the quantity and quality of the seeds (small seeds, wrinkled and black).
- *Cleanliness of the place is not maintained.*

The sanitation conditions around the land / garden are still lacking in sanitation. The remains of dry leaves, dirt, garbage, weeds (grass) and employee cigarette butts are still scattered around the land.

b. Broken Seed

Human disability is caused by:
- *Employee negligence in wor*

Employees neglect to pick young (immature) *edel* cocoa beans and get carried away. The *edel* pods are clustered, making it difficult for workers to pick ripe pods so that the young *edel* pods are accidentally picked by workers. Another negligence is the carelessness of the *edel* pods that can cause the *edel* pods to break and cut by the crusher.
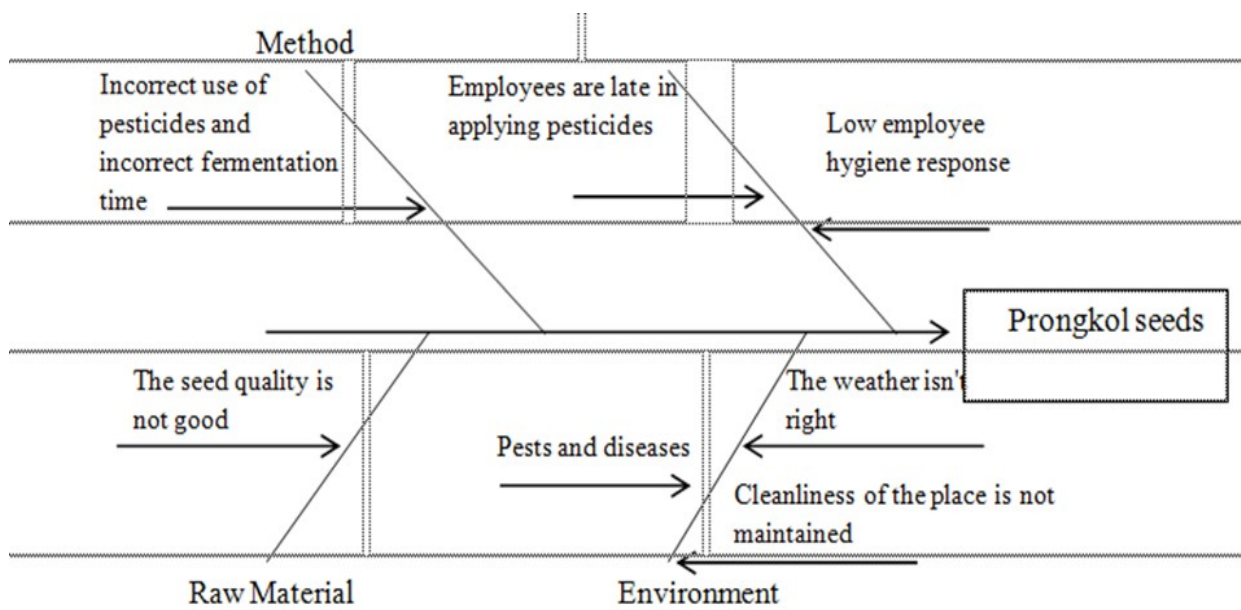
Figure 4. Cause and Effect Diagram of Broken Seed Defects

Edel cocoa beans can be injured by scratches, and a serious mistake is that whole beans can become cracked beans.

A further negligence is the process of reversing the drying which is hasty and careless when drying in the sun which results in the seeds breaking due to using a toothed back rake and uneven floor conditions. The seeds cracked because they were exposed to the reversing rakes that were too tight.

- *Lack of attention to early symptoms of VSD (Vascular Streak Disease)*

The knowledge of freelance workers and staff employees is still lacking, so the early prevention of VSD is not handled optimally. There are other factors such as working time that is not used optimally due to labor employees who still use a lot of time to rest. In fact, the existing working hours should still be used for the maintenance of *edel* cocoa.

Method, broken seed defects are caused by:

- *Manual fruit breaking (not yet standardized) and wrong cutting process*

Fruit breaking must be avoided from the possibility seed injury during the process because it is susceptible to fungal attack that comes from the air, soil, water,

or from the surface of the fruit skin. *Edel* cocoa cracking at PT. Perkebunan Nusantara XII (Persero) Kebun Banjarsari has not yet used a pod breaker machine. This results in the breaking process not yet standardized, so the intensity of the injury to the *edel* cocoa beans has the potential to increase if there is no standard work procedure in the company. *Edel* cocoa beans are sticky after the fermentation process, can be cut with scissors, so that the quality is intact, but employees' carelessness when cutting *edel* cocoa beans can cause the beans to crack.

Material defects of broken seeds are caused by:

- *The seed quality is not good because of disease*

Disease in cacao edel is (Oncobasidium thebromae) commonly called VSD (Vascular Streak Dieback) which is caused by the fungus Oncobasidium theobromae. The fruit produced when the *edel* cocoa is affected by the disease is small and the *edel* cocoa beans are brittle, and break easily.

Cracked beans can also be caused by young (raw) beans mixed in the edelized cocoa beans that are harvested. Dried young beans tend to produce dry *edel*

cocoa which is easily brittle, so it breaks easily.

The defect is broken down from facets environment caused by:

- *Weather and temperature do not match*.

Unfavorable weather and temperature can affect the condition of *edel* cacao. Erratic temperature and weather always make the growth and reproduction of fungi cannot be suppressed due to insufficient supervision optimal. Extreme humidity can support increased mold growth. Especially if no regular pruning is done and the weather rains every day.

- *Wind conditions due to erratic weather.*

Wind may be a major cause of the spread of the fungal spores that cause VSD. Erratic weather causes strong winds, especially the rainy season. Production carried out on open land causes *edel* cacao to grow frequently exposed to wind and the spread of VSD disease fungal spores.

- *Cleanliness of the place is not maintained*.

Edel cacao fields still have a lot of weeds, garbage, dirt that is rarely cleaned due to lack of supervision and extensive garden land. Dry leaves and fruit fall and then rot, garbage, dirt is not picked up, and labor employees are only concerned with harvesting according to company demands and targets.

c. Black Seed

Black seed defect is caused by:

- *Employee negligence in harvesting*.

The timing of harvesting *edel* cocoa will affect the quality of *edel* cacao. *Edel* pods should be picked when they are ripe enough. Overripe seeds, pulp content will dry out, the color of the seed coat turns black and sprouts grow inside the seeds. Harvested cocoa pods that are too ripe can result in defects in the form of rotten beans marked by the skin and contents of the beans black color, when exposed to water it will germinate, resulting in sprouts because cocoa beans do not have dormant time after the ripening process.

- *Lack of employee knowledge in the edel cocoa production process.*

Harvest delay could resulting in overripe *edel* cocoa beans and a lot of pulp which affects the fermentation process.
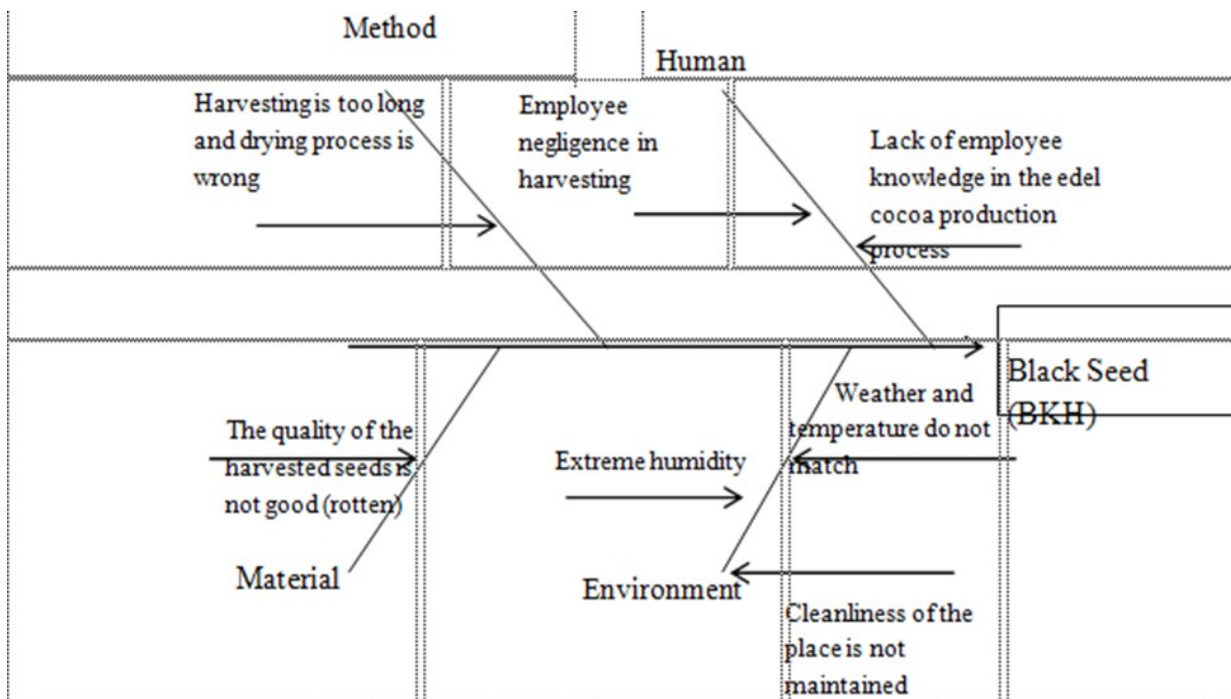

Figure 5. Cause and Effect Diagram of Black Seed Defects

Black seed defects in terms of method caused by:

- *Harvesting is too long.*

    PT. Perkebunan Nusantara XII (Persero) Kebun Banjarsari, harvesting *edel* cocoa after the plants reach the age of 5 years. Harvesting by twisting the fruit, kicking, or pulling the fruit is not recommended as it can damage the stalks and injure the plant. Damaged fruit stalks can no longer grow cocoa flowers and injured plant skin will easily become infected with pathogenic fungi.

- *Wrong drying process.*

    Drying using artificial drying. Incorrect supervision and processing can cause case hardening, namely defective beans whose surface is very dry (black), while the material (content) is still wet.

    Material defects of black seeds are caused by:

- *The seed quality is not good (rotten).*

    Healthy fruit will be contaminated by rotten fruit if piled up in the same place. Contaminated fruit will produce defective *edel* cocoa beans as well. The wrong sorting process in the garden results in poor quality *edel* cocoa beans, produced less well and decreased productivity.

    Environmental aspect of black seed defects is caused by:

- *Extreme humidity.*

    Extreme humidity conditions can encourage growth and breeding of fungi that cause fruit rot, namely the fungus P. palmivora. This is because the shade of the *edel* cocoa plants is too dense and tall, and there is no routine pruning from the employees.

- *Weather and temperature do not match.*

    Fruit rot (Phytophthora palmivora). The spread of P. palmivora fungus through several ways, namely by sprinkling rainwater, direct contact between sick fruit and healthy fruit, and animal intermediaries.

- *Cleanliness of the place is not maintained.*

    The cleanliness conditions of each plant are very influential. Rotten or defective *edel* pods must be separated so that they do not spread to healthy pods.

Proposed Improvement

    The suggestions for corrective action for *edel* cocoa bean pod defects at PTPN XII (Persero) Kebun Banjarsari include:

a. Improvement of employee skills through counseling and training on procedures for controlling pests and diseases once a month,

b. More regular supervision, training and how pesticides work,

c. There needs to be an intensive and regular schedule of pesticide use,

d. Initial supervision of *edel* cocoa beans and separation of *edel* cocoa defects and good, planned production so that the initial factory acceptance supply is not overproduction that causing the seeds to stick to each other,

e. Provide alternative action by planting diversified cover crops, and natural enemies.

    Proposals for corrective action of cracked *edel* cocoa beans at PTPN XII (Persero) Kebun Banjarsari include:

a. Provide direction and firmness to employees so as not to rush into breaking the *edel* cocoa pods.

b. Giving work breaking cocoa pods to people who are skilled at using tools.

c. Turning the *edel* cocoa when drying requires a tool that is not sharp, which does not injure the skin and even the beans.

d. Using modern drying as will be developed today, namely by means of mechanics

e. Monitor cocoa *edel* and routine checks, especially to the EWS (Early Warning System) team.

f. There needs to be a modern and standardized fruit breaking so that the fruit breaking is a pod breaker. The need for it supervision pruning already tall shade plants and shade plants.

    Proposals for corrective action for black bean defects of *edel* cocoa at PTPN XII

(Persero) Kebun Banjarsari include :
a. Monitor and reprimand when the harvest is taking place, and remind them to pay attention to the correct harvest guidelines, especially the timing of the harvest.
b. There needs to be a regular schedule for harvesting *edel* cacao according to the planting year.
c. Increased supervision of employees in the use of artificial drying so that drying errors do not occur.
d. Always check regularly at initial acceptance (wet sorting).
e. Check temperature and humidity regularly to prevent the growth and proliferation of viruses, bacteria and fungi.

Check temperature and humidity regularly to prevent the growth and proliferation of viruses, bacteria and fungi.

CONCLUSION AND SUGGESTION

Types of defects that occur in edelized cocoa beans include prongkol beans, broken beans, black skin beans, kepek seeds, mouldy beans, and insect beans. Based on the proportion control chart (p chart), it is known that *edel* cacao defects for 5 years from January 2015 - October 2019 still exist which is out of control. Deviation outside the upper control limit occurred in September 2015 and August 2019, while the points which were in the lower control limit occurred in September 2016 - November 2016 and July 2017 - September 2017. The dominant defect that occurred in cocoa *edel at* PT. Perkebunan Nusantara XII (Persero) Kebun Banjarsari namely prongkol seeds, broken seeds, black skin seeds with a cumulative percentage of defects reaching 79.97%. The disability is caused by 4 factors, namely human, material, method, and work environment. The suggestions for improvements that can be implemented are:
a. Factor Human:
    Provide training and counseling and take firm action against employees who violate regulations.

b. Factor Method:
    Carry out activity procedures according to working hours, discussions, and accompanied by inspection and control of *edel* cocoa.
c. Factor Material:
    Supervise and check regularly.
d. Factor Environmental :
    Take alternative action by planting diversified cover crops, sanitation and weed removal around the garden land.

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